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THE ART AND SCIENCE OF COMPOSTING
(Recent Observations and Testing Methods)

EHRENFRIED E. PFEIFFER

The following paper, by Dr. Pfeiffer, is *definitely technical in nature and not "light reading". Nevertheless, it can be heartily recommended to all readers of Bio-Dynamics, whether or not they are scientifically inclined or professionally interested in compost making. From it we can derive a better understanding of what goes on in, for instance, our own backyard compost or manure pile. And there are details in the presentation that are of immediate practical value for the home-garden composter as well as the large scale producer. It embodies results of the author's recent experiences and latest research in this basic field. Ed., B.D.*

It is obvious that the chemical analysis of a compost with regard to its nitrogen, phosphate and potash content (NPK) gives only limited and incomplete information as to its biological value. Nor does it really tell how good a compost is. There are plants, the roots of which are very sensitive to raw, crude, decaying materials, which demand the very best humus—for instance, legumes and fine grasses, and there are others which thrive well on crude matter—such as corn, tomatoes, grapevines. There is not just *one* compost for everything, nor is all the organic material or waste (from the moment it arrives in the dump or compost yard, and on through all stages of fermentation and decay) yet to be defined as compost.

To know, properly judge and evaluate the biological quality of a compost is not only important for the farmer, gardener and orchardist so that he can select the proper type and amount to be applied with the optimal result and least expense or waste, but it is more important for the compost maker in the small garden or the manufacturer in a big way. He has to have such knowledge in order to produce the best material with the least expense and the least losses of organic matter, nitrogen or other ingredients of value.

The problem has been complicated by the fact that composts with almost the same NPK content in pot and field tests have

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given quite different results with regard to growth, yield and state of health of plants because of the difference in their biological or intrinsic value. One experimental station in Germany recently compared various composts from municipal garbage compost operators and found that one compost from the pilot plant in Erlangen produced in test plots of spinach and carrots a far better yield, even though this compost was applied at a rate of one-fourth of the others, and its NPK was equal to that of the three or four others which were used for comparison. Experiments performed by the Portuguese Experimental Station in Ponta Delgada, Azores, with compost also made with the B. D. Compost Starter showed that an application rate of compost one-seventh that of the best farmyard manure produced equal yields. This, in turn, led to the fact that the government granted a 20% subsidy (20% of the retail sales price) to the compost manufacturer to make this compost available to the farmer. In terms of value, it was estimated that the intrinsic value of such composts is equivalent, if not a bit higher, than the NPK value because of the presence of organic matter, of trace minerals, and in view of the increased availability of all minerals due to certain bacterial action and the quality of the humus, that is, fully digested organic matter (not crude organic matter). All these factors we will call biological value.

While it is easy to make analytical tests for NPK following the officially recognized methods (AOAC) (1), it has been thus far a difficult problem to determine the biological value. One problem has been what to look for; another, how to develop adequate analytical methods.

The Biochemical Research Laboratory of the Bio-Dynamic Farming and Gardening Association, Inc., has devoted much study to these problems over the last ten years. It has worked on setting up proper composting methods with the highest degree of efficiency, and has developed testing methods which make it possible to judge the chemical as well as the biological value of compost. Some of the methods will be described in this article. Before we can do this, however, the processes of composting, and the happenings during the fermentation must be described. The author of this paper has incorporated his knowledge and observations in a manual which discusses our knowledge in detail with a view to large scale waste composting. (2) This article will serve as a supplement to this manual, elaborating further on the problem.

In the literature, we find various methods described for the determination of so-called "humus". Humus is not a definite chemical substance but a state of matter, an integration of mineral with organic matter. There is, for instance, the acid humus in forest soils which is entirely different from a neutral, colloidal humus; there is the alkali soluble humus; there is the concept of Prof. Singer (Munich) of "effective organic substance". To determine these, good analytical methods have been developed. (3, 4) All of these methods are valuable but still do not give a complete picture of the biological situation.

It is in the nature of composting that one deals first with waste materials, garbage, plant refuse from gardens, lawns, stubble, old hay or silage, seed cleanings, cotton burr, slaughterhouse refuse, field (crop) refuse, sludge, pea vines or other refuse from processing of agricultural products, pomace, oil press cake, manures of all kinds, leaves, conifer needles, wood shavings, sawdust, etc., etc. All of these are not yet compost nor are they humus. Between these raw or source materials and the final product is a long chain of reactions and transformations. All of these substances are called organic — not so much because they contain strictly "organic matter", (that is, are compounds of carbon, nitrogen, oxygen, plus sulfur, phosphorus in the organic molecule), but because of their origin from an organic process, i.e. the growth and life to which they owe their existence.

The final product is compost, humus, in various degrees of decay or fermentation. At the very end of all that, in touch with soil, compost earth and a humus soil will result under favorable conditions. Under unfavorable conditions, just "earth" will result with a rather low content of organic matter; that is, the product has become mineralized and the goal of creating "organic" matter for the soil has been overshot. Nothing of the structure and nature of the source material has been left.

In the manual (2) three phases of composting have been discussed:

First: The breakdown phase, which effects the primary change of the crude source material; the original proteins, amino acids, proteids, cellulose, starches, sugars, lignin, are broken down. This could happen by ordinary decay without the interaction of micro-organisms (bacteria, for one), but usually micro-organisms, bacteria, fungi and microscopic animal organisms, which digest the raw materials, are present.

Second: The building up phase. Micro-organisms take over and transform the source materials, which they use as food, building up their own bodies. Now it becomes very important which type of microbial activity is present; such as results only in the release of carbon dioxide, ammonia, nitrites or hydrogen disulfides, or the other which stabilizes the breakdown and produces either a stable humus or an unstable humus, a lasting or a perishable humus. The stable humus will build up a soil, the unstable, perishable humus will provide plant food but will "burn up" in the soil quite rapidly and will not have any lasting effects. With regard to the application of such composts, it is quite important what kind of soil is to be fertilized. For sandy soil, with its greater access to air, its faster warming up in spring, needs more stable, lasting humus, while heavy clay and loamy soil will benefit more from the unstable quick decomposing humus, even though a certain amount of stable humus also is necessary in order to build up these soils.

Third: Gradually the organic matter will be more and more decomposed, get lost as carbon dioxide, lose nitrogen via ammonia and nitrites; that is, the original proteins and amino acids are completely broken down into the simplest chemical compounds and therefore the compost mineralizes. The result can be favorable. Then we have the rich compost earth which in older days was called "compost" and was produced mainly by the home gardener and farmer, but the organic value is much reduced, below the potential of the source materials.

In practice we find, therefore, composts with as much as 40%, 30%, 20%, 10% or less of "organic matter" (determined by the combustion or oxidation method) no matter whether the original content was 60%, 50%, 20% or less. Most old-fashioned garden composts contain 8% to 16% organic matter. Very few manufactured composts contain as much as 30% organic matter, and still fewer more than 40% organic matter.

To say that a compost is 100% organic is misleading. It can be 100% organic because of its origin (made entirely from refuse of material exclusively produced by the life process of plants and animals), but it certainly does not contain 100% organic matter. This is due to the nature of living tissue (or cells) which consist of 70% to 90% of water, 15% to 20% of strictly "organic" substance, that is, proteins, amino acids, carbohydrates — in short, carbon compounds and of 2% to 10% mineral, inorganic matter, phosphate, potash, calcium, magnesium, major and minor (trace)

inorganic elements. Nitrogen is part of the organic substance; part of the inorganic matter can be present in organic compounds but also can be present as salts or otherwise. Mineral compounds present in organic matter are less doomed to being washed out than those present in strictly inorganic states, for instance, salts, above all potassium. This is true as long as the organic compounds are stabilized.

Now there is in addition quite a difference whether these organic compounds are preserved — that is to say, locked up in the living bodies of micro-organisms, or are "floating" free in some phase of breakdown. Only if they are locked up, will they be stabilized. As soon as there are conditions of moisture, warmth or aeration favoring them, the breakdown and loss will continue. While the home gardener or farmer has only a limited control of these processes, the industrial manufacturer would do well, even if for nothing but economic reasons, to make himself familiar with the scientific background of composting. He needs this for production control, maximum efficiency, to save and not to lose valuable substances and, finally, to come up with a product of high quality and biological value. It is of course true that the mere NPK concept applies correctly once the completely mineralized state of compost has been reached, for then all the intrinsic biological values have been lost.

It is necessary to follow all these processes carefully, with experience, know-how, and where possible with analytical methods. The compost maker of large quantities needs this knowledge. In fact, the farmer and gardener should also know and appreciate these differences, for they are the key to the application rates, even though the NPK content may not vary widely, and the efficiency in application consequently also is different.

The farmer can save himself a lot of money if he uses compost with a higher biological value. He needs to use a much smaller quantity per acre. Think only of the difference in loading and spreading time and the lessened compacting of the soil because of traveling less frequently over the field. To the producer, it also means dollars and cents, for the cost of handling is about the same whether he produces a high or low quality of compost.

In our laboratory we have analyzed hundreds of composts. We have seen few with 40% or more organic matter and a high

availability of minerals but many with 12%-16% organic matter and low availability of minerals.

The difficulty so far has been that no one simple method of analysis existed for determining the biological value of compost. We shall now discuss the various methods of analysis and evaluate them. To many of our readers, this may be like Chinese, but they would do well to read it nevertheless, for this knowledge is to their benefit.

pH: determines the degree of acidity, alkalinity, 7.0 is neutral, 8.0 or more is strictly alkaline, below 7 is acid, 5.5 would be very acid. Decaying materials, because of the release of organic acids, are acid — between 5.0 to 6.5. Such acid composts, therefore, belong mostly to phase 1. All natural, biological, aerobic bacterial action proceeding towards humus formation tends to produce an alkaline reaction, from 7.5-8.0 in general. When a compost moves from acid to neutral, it indicates that the second phase takes over. 7.5-8.0 indicates the beginning of stabilization. A few exceptions may exist; leave this to the expert to understand. pH meters or, for quick orientation, colorimetric indicators, are used. Different methods give somewhat different values.

Total Organic Matter: is determined by combustion or oxidation of the carbon compounds. This determination does not tell the state of matter in which the organic matter is present. A piece of coal and a plant protein or cellulose can not be differentiated. However, this testing is very valuable for following the gradual vanishing of organic matter during fermentation, downward from the original content. During phase 1, this downward trend is greatest because many micro-organisms which effect the breakdown consume organic matter and produce carbon dioxide. During phase 2, a stabilization takes place. Under very favorable conditions, so many organisms can grow as to produce a slight increase of organic matter, as plants would grow on a field, so as to compensate for the earlier losses or even improve on them. It is therefore important to go through phase 1 as fast as possible and to arrest excessive losses in phase 2. On this rests the success or failure of economic and efficient composting.

We have seen many composts where 50% and more of the original organic matter was lost. The higher the original content, the greater the danger of losses, the more carefully one must work. The danger of losses is greatest with hot and fast fermentation. This method, which we favor because of its greater econ-

omy, needs considerably more skill and knowledge than the cold, wet fermentation. The latter is the old-fashioned garden pile method, with 50% moisture or more. The entirely different anaerobic sludge fermentation shall not be discussed here. The fast hot method of fermentation works with a moisture content of from 30%-40%, while a dry product below 20% shows no appreciable action, by the way. This method, therefore, needs much knowledge and continuous control.

We repeat: the knowledge of the kind of organic matter one has is important in order to introduce and judge the process to be decided upon. The organic matter test alone will not give the answer to this question. Whether, in the laboratory, ashing in a crucible or a combustion train or the wet oxidation method gives more reliable results, is a matter for discussion, involving circumstances and details which need not be gone into here.

The final breakdown product of the carbon in organic compounds is CO_2 — carbon dioxide. Many organisms of phase 1 produce CO_2. The more active they are, the more CO_2 escapes. This explains in part the losses of organic matter. It is quite essential that natural processes or biochemical shifts take over before the carbon dioxide is formed and the materials are used by other organisms prior to the final breakdown into CO_2, ammonia or free nitrogen. In our laboratory, we use in fermentation tubes measured samples of compost and determine the amount of CO_2 which is produced over a set period of time — 2, 3, 5, 7 and 14 days. This gives a measure of the intensity of breakdown and organic matter losses. In the composition of the B. D. Compost Starter, we have reduced the presence of CO_2 producing organisms to the absolute minimum, with the hope that the other more economical organisms grow fast enough to outgrow or to crowd out such wasting organisms which are naturally present in waste materials.

Inorganic Matter: The ashes of the combustion test, again, give only the sum total and in no way inform one as to the origin, namely, from minerals or formerly living cells and tissues. To analyze these ashes for their composition involves complicated analytical procedures. Spectographic tests may serve as an initial orientation but are not reliable, not so much because of the method used as because of sampling errors. The heterogeneous material of small samples would need many repeated tests to arrive at an acceptable average. This is a matter for the skilled chemist.

Moisture: The determination of moisture is important, not only for the final product but throughout the fermentation. Micro-organisms are very specialized, are adapted to specific moisture levels. The moisture content, therefore, will indicate which organisms under certain given conditions will survive or "go to town" or remain inactive.

The study of soils gives much information on the subject of the ideal moisture content for fermentation, which is quite different from that needed for arresting and keeping finished material.

As soon as the cell structure and walls of the source material are destroyed, mechanically or biologically, moisture will ooze out. In the beginning we will therefore frequently have too high a moisture content. This is the case especially with swill, fresh sludge, pomace, cow or hog manure. Excessive moisture predisposes to anaerobic fermentation, especially if the compost piles are packed, compacted and of great height and width, or set up on poorly drained soil where a lot of outflow from the piles and rain water collect.

A Russian paper of 1911 (the original has been lost and the source cannot be quoted) explained that the ideal conditions in neutral black soils in the Ukraine, which belong to the most fertile humus soils, were maintained when the precipitation rate and the evaporation rate of water were balanced. This soil would absorb moisture and hold it but never looked drenched or wet. We compare this condition with that of a wrung out, not dripping sponge. This condition secures optimal aeration in a soil. Air is important, for most of the humus-forming micro-organisms need air for breathing. Also, nitrogen fixation takes place best in the topsoil, for these organisms acquire nitrogen from the air. If they are excluded from air, they will consume nitrogen from the organic waste and thus cause considerable nitrogen losses. Fast, hot fermentation works best with a moisture content ranging from 30-40%; a slow, cold, aerobic fermentation works best with a moisture content between 40%-55%; the upper limit for a favorable and economical aerobic fermentation is 65%. A higher degree of moisture will lead to considerable problems; will favor decay or putrefaction for a while until the heat of a compost pile and the thirst of the micro-organisms have reduced the moisture to an optimal level. Frequent turning, or flat piles may speed the drying out, provided it does not rain on them; if it does, then matters get worse.

The control of moisture in industrial composting is considered so important that we recommend a moisture tester for such plants and would correct excess, as well as too low a moisture, at once. Too low a moisture is corrected exactly as per calculation; that is, we do not pour on water but measure it out. Here the home gardener or farmer is at a disadvantage and has to take it as it comes. Eventually, he too will get humus or compost soil, for this is the final state of all things: the return to soil.

Total Nitrogen: The analytical method for nitrogen determination is strictly a laboratory method and needs skill. It tells only the amount of nitrogen and not where the nitrogen comes from. Within the reach of the chemist are also methods of determination of ammonia nitrogen, nitrite nitrogen, nitrate nitrogen; also quick extraction methods for the latter, as for soil tests, which in the field are helpful for quick orientation. For exact determination, the AOAC methods are the only ones permissible.

For control of compost fermentation in the compost yard, the quick extraction methods are useful to find out how much ammonia, nitrite and nitrate a pile develops. Ammonia is the breakdown product of bacterial action or decay of nitrogen containing compounds and may be considered as an "end" product of breakdown. (In living animal tissue this would correspond to the N-metabolism and the formation of urea.) In the field, the smell of ammonia indicates the degree to which the source materials are broken down and nitrogen eventually lost. It is in the interest of economical composting to interrupt the production of ammonia before it is too late, or to direct a fermentation in such a way that the bacteria take over and rebuild more stable nitrogen compounds — for instance, in bacterial protein. To establish this balance is really the "secret" of successful and scientific composting. The means are: control of moisture, aeration, proper mixture of original ingredients, turning of a pile at the right moment, interrupting prolonged excessive heat by turning. The value of nitrogen saved will more than compensate for the expense of turning with suitable equipment. In large scale operations, the advantage is that excellent machines for this purpose are available which are expensive to buy but pay for themselves by cheapest operating cost. With one Barber Greene overhead loader (purchase price $15,000), we were able to turn and mix piles at the rate of 60-80 tons/hour at a cost of 20c per ton (everything included — labor, maintenance, depreciation, etc.). The small compost maker is again at a disadvantage here. How-

ever, by turning and mixing a pile at the right moment one is able to save a lot of N losses and to convert more quickly into humus. The human nose is very sensitive to the odor of ammonia. A so-called strong smell might mean a concentration of only 0.1% of ammonia, a weak odor of 0.01%, which is negligible.

If a pile develops too much heat and ammonia, we turn it immediately together with another pile which has cooled down already and does not smell of ammonia. With the use of the Barber Greene, this is no problem whatsoever. Maybe in the near future we will have smaller, inexpensive machines for medium-sized production; by this is meant 500-3,000 tons/year. To be remembered; ammonia is always the indicator of the breakdown process and the presence of prevalent ammonia-producing micro-organisms.

Less noticeable is the breakdown into nitrite by other micro-organisms. This form of nitrogen will fall apart very easily and release free nitrogen, usually a total loss. These bacteria, therefore, are not desirable at all, though they are very helpful in the initial phase of breakdown (phase 1). The problem is to interrupt their activity at the earliest possible moment, by the same methods as given for ammonia, and to introduce, as fast as possible, phase 2 of the fermentation. Aeration also will help to foster the third group of organisms which either form nitrates or fix nitrogen into more complicated organic compounds, for instance, bacterial protein and amino acids. Nitrites and nitrates in the field can be determined by quick extraction methods, as used for soil. In fact, they must be determined in this way, unless a laboratory is nearby, for a sample taken and shipped will change very rapidly, so that the ammonia and nitrite situation is obscured, while nitrates in a dry sample have more stability.

In the laboratory we determine the presence of ammonifiers, nitrifiers or nitrate formers by using fermentation tubes as for bacteriological research. The compost sample or the pure culture, as the case may be, is kept in such fermentation tubes in the incubator at controlled temperatures (we use 29°C.) and the amount of ammonia, nitrite and nitrate produced by a weighed sample is measured after 3, 5, 7 and 14 days. In this way, we gain a deeper insight into the actual processes present in any given sample and corresponding to the situation in a pile.

One could also arrive at an answer by separating and isolating the organisms on culture media and determining the species, etc., proper. But this is a long, drawn out affair which needs

skilled personnel specifically trained in the bacteriology of compost fermentation, which is not taught as yet, and for which no textbook exists.

If it is said that one can leave all this to nature, that proper conditions will establish themselves, this cannot be denied. This is what has happened ever since there has been soil. But the economy of compost making demands doing better than that; it requires introducing time-saving and material-conserving methods. This is a necessity if one wants to do business. Since the proper conditions for the many organisms involved can be studied, it is not too difficult to introduce proper procedures. Those who deny that just prove that they don't as yet know the facts.

The appearance of nitrate comes at a later stage of fermentation and is a sign of beginning stabilization and mineralization. In fact, a finished compost should contain only stable organic nitrogen and a small amount of nitrates. With regard to soils, it is said that about 5% of the organic matter of a soil would be present in the form of nitrogen. This, of course, does not include undecomposed matter or green manuring.

As a rule of thumb, this applies to many composts too. The point should not be pressed too hard but serves for swift orientation.

During the breakdown phase, the presence of free amino acids can be demonstrated by chromatographic methods. We use one method which has been published elsewhere. (5) Likewise, the presence of amino acids can be demonstrated in humus soils, especially those on which legumes have been growing over longer periods, while rundown, mineralized soils show less variety of amino acids and less of each amino acid. No doubt, organic nitrogen in well rotted, stabilized compost is bound to proteins and amino acids. When the fermentation is completed towards the formation of humus, none, or very few, amino acids show up because all nitrogen is fixed to higher forms of life. The same is true of simpler organic acids — acetic, citric, maleic acid, sometimes oxalic acid; that is, acids with no nitrogen, which also appear in the free state only during the breakdown. Our readers may now begin to understand why the term "total nitrogen" cannot cover the differentiation as to its origin, biological value, stability or instability, availability, quick or slow release in a soil, all of which are important factors for the efficiency and application rate of compost — in short, factors of quality and value.

The problem of the C:N (carbon:nitrogen) relationship has recently been discussed and thoroughly investigated, so that it is not necessary to go into detail here. (3,6) As long as the relationship is excessively in favor of carbon, for instance, 44:1 as in straw or sawdust, so much organic matter must be broken down and is eventually wasted as is necessary to reduce the C:N relationship to a favorable bracket. The ideal figure is said to be 11:1 but, in practice, we found that at a rate of 20-22:1 one already gets a good and economical fermentation. If it is not possible to mix high nitrogen-containing source material with low nitrogenous materials, a nitrogen correction must be applied by the addition of specific sources, such as hoof, horn, hair, castor bean pomace, fish, blood meal, or poultry manure. Of mineral nitrogen compounds, calcium nitrate has been found most beneficial, while urea and ammonium sulfate have to be added with great care because of their easy breakdown and quick release. Ammonium nitrate is dangerous, for with dry compost it may form an explosive mixture.

The narrow C:N relationship of 8:1 or less is highly exposed to too quick a release of nitrogen and very unfavorable for stabilized composting. It is here that greater problems exist if one wants to break down, without losses, such materials as we have mentioned above as corrective additions.

Theoretically, this can be expressed also in other terms. A content of 1.5% nitrogen in compost or manure is the upper borderline of stabilization. (6) Above that limit, all materials will tend to produce ammonia and lose nitrogen. It is much better to adjust the formula of mixtures right from the beginning so that one does not exceed the critical concentration; then one has the best chance of not encountering carbon and nitrogen losses. Once the breakdown has gained momentum, it is quite difficult to arrest the downward movement. Within a few days, one will observe that a 2% N content has been reduced to 1%. Many manures have 1.5-2.5% N when they leave the animal. At the time these manures are applied to the field and worked into the soil, they have run down to 0.5% N. No wonder many agronomists say that manuring is a wasteful procedure. The U.S. Dept. of Agriculture recommends the immediate plowing under of manures. This, alas, is no solution of the problem, for the devaluation takes place in the soil. The composting and stabilization of manure would be a much more conserving practice provided that one knows how to do it.

Ammonia is preserved that is, fixed in acid solution but liberated in alkaline media. Since the biological process tends towards the alkaline, the ammonia-producing phase must be overcome, the earlier the better. For nitrogen fixation and such organisms as azotobacter and nitrosomonas, the presence of lime (calcium) even in small amounts, is beneficial.

Unless one deals with very acid and wet materials, we feel that lime should be added only to the second phase of fermentation; then, however, it is very beneficial. One needs only 50 lbs. of limestone, finely ground, per ton of compost. In areas of limestone formation, with the water and plants containing more calcium, this may not be necessary. In fact, in some such areas calcium damage to acid-loving plants has been observed when just plain garbage was composted.

Quick release of ammonia and calcium damage are part of the reason why "reinforced" composts cause burns on lawns, flowers and shrubs; they were "too rich". Undecomposed poultry manure is known to cause such burns.

While it is relatively easy to get composting under way, because it is in the nature of the materials involved to get started with "some" kind of breakdown, (decay will always be the result), it is more difficult to direct this decay into definite channels of fermentation and to correct an undesirable trend. The knowledge of all the factors mentioned so far is of help, but the home gardener, farmer or even the manager of an organic composting plant will ask: how do I get to know about it without a laboratory? Our advice in the past was to (a) use as many different materials as possible for composting, for then you will have the best chance of getting a little from every process; (b) in order to brake violent one-sided action, use soil as addition, which acts as a kind of buffer; and also favors the development of the phase 2 organisms; (c) control your moisture; (d) in case anything goes wrong, turn your pile. Excessive heat is as undesirable as a cold, wet, lame-duck. Excess of anything is undesirable.

We could, of course, give composting classes, showing the different types of fermentation and of behavior of source materials and explaining why and how the pile looks, smells and has its particular structure. One would show, for comparison, controlled experiments with most or even all the contributing factors known. In this way, the layman could learn by comparison and can orient himself by the examples. I have on occasion giv-

en such instructions and demonstrations. Usually the audience begins to tell how *they* make it, assuming that their method is gospel. To me it is a puzzle why in this field we have so much dilettantism, and from the side of scientific prejudice.

The plant manager in charge of large scale composting, in order to make the operation efficient and economical, needs some basic information; knowing the temperature, moisture, organic matter, nitrogen, structure and degree of aeration are all musts. It is important for him to know when to turn a pile, when to interrupt fermentation, when and how much water to add. It must be realized that some of the tests we have mentioned above, especially isolation of micro-organisms and fermentation tests, take time, and the compost is probably stockpiled or sold by the time the results come in.

Temperature can be read in a few minutes; a moisture test with suitable equipment takes up to ¾ to 1 hour; a micro-Kjeldahl test for nitrogen about 1 hour, the macro test longer; organic matter by combustion several hours. (These need analytical equipment, exact scales and some experience.) All these tests indicate details. We have been looking out for a simple method to check the over-all pattern. We have tried the sensitive crystallization method of this author which, in the checking of other biological materials, has performed quite satisfactorily. With regard to compost it may give some information, but the method is too cumbersome for practical surveys. For the last three years, we have been using a method of circular filter paper chromatography which has performed quite satisfactorily and is rather simple, requiring very little equipment. This method is based on the property of filter paper to separate fractions in a solution by way of capillarity. It then needs a reagent to "fix" the fractions and make them visible.

CHROMATOGRAPHIC DETERMINATION OF HUMUS EXTRACTS FROM COMPOST FRACTIONS

Principle:

The test described is a qualitative one in order to separate different fractions of humus extracts by means of the capillarity of suitable filter papers. The filter paper is prepared with a photo-reactive substance, for instance, silver nitrate, which also reacts with the extraction substances.

The precipitation of this reaction occurs at various distances from the point of application of the substance to be tested. The distance, the pattern, the color and the shape of the reaction

area are significant for an interpretation of the substances contained in the extracts.

In using this method, no attempt is made to identify the chemical nature of the reacting substance, since the pattern obtained can itself be used as a diagnostic means. However, identification is possible. Of the different possible techniques for chromatography, the circular method of chromatography was selected since it gives easily obtainable results with simple equipment and is easy to interpret. All other methods, descending as well as ascending methods, by filter paper or chromatographic isolation by means of filter columns would require considerably more time and apparatus.

METHOD:

1. *Preparatory Steps*:

(a) Circular filter paper discs are used of Whatman No. 1 paper 5⅞ inch (15 cm.) diameter. A hole is cut in the center, about 1/16 inch diameter.

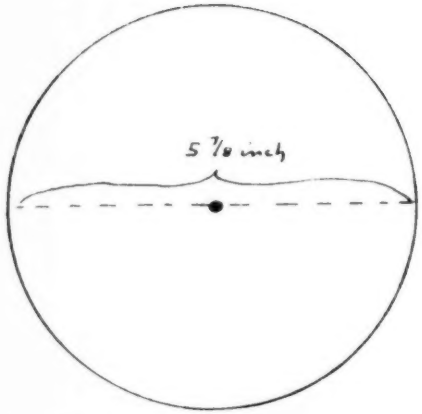
(b) A wick is prepared of the same filter paper by cutting strips of ¾ inch square and rolling them tightly into a cylinder. This wick is placed into the center hole, protruding on either side of the disc but so that it touches the bottom of the porcelain dish underneath (cf. e). It is important that the wick touch evenly on the circumference of the center hole in the filter paper disc in order to make a good, homogeneous contact.

(c) Make pencil marks at 1½ inch and 2⅜ inch distances from the center to indicate how far the solution should penetrate or be absorbed (see sketch). Depending on the run of the fibre in the filter paper, the solutions sometimes spread quicker in one direction than in the other; hence the double pencil marks in two different directions at a right angle (see sketch).

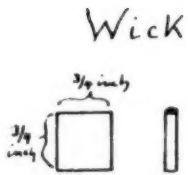
(d) Have a 0.5% solution of nitrate of silver, Ag NO^3, tested purity, in aqu. dest., available. The solution is to be kept in a brown or green bottle, not exposed to direct sunlight (no cork stopper) ; it can be made once a week. In any case, it should not be too old and not show any dark rings or deposits.

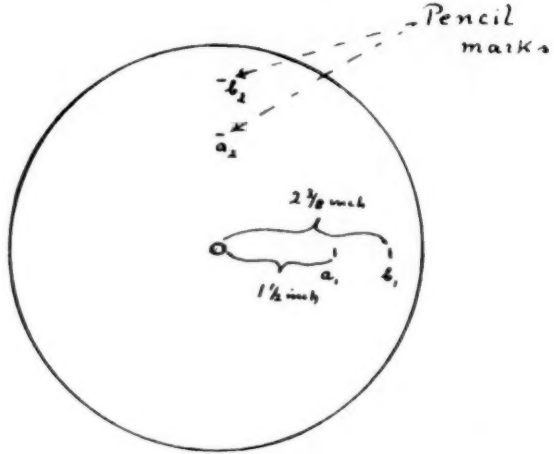
(e) Place the filter paper disc with the wick on a petri dish of 3½ inch diameter, center over center; the height of the petri dish is ⅝ inch. Inside the petri dish, center over center, is a porcelain dish of 1¾ inch diameter and 7/16 inch height (see sketch).

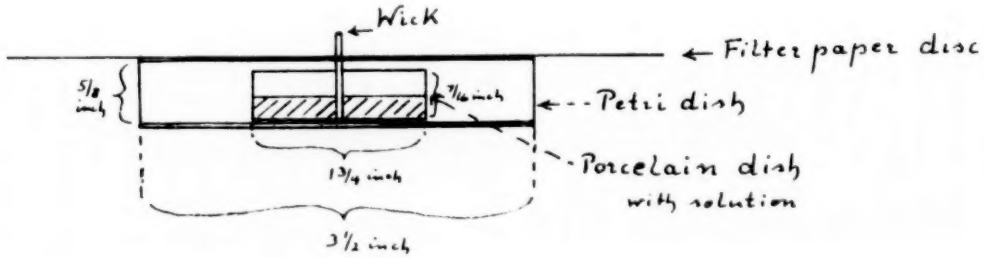
(f) Pour 3 ml of the 0.5% Ag NO^3 solution into the porcelain dish; remove the filter paper disc before pouring and replace



Filter paper disc
(Whatman # 1)







it. This 3 ml amount of Ag NO^3 can be used for the preparation of 3 filter paper discs in succession.

(g) The solution of 0.5% Ag NO^3 will, by capillarity, spread over the disc, radiating in all directions. When it has reached the first pencil mark at 1½ inch distance (a_1, or a_2 — see sketch), remove the disc immediately from the petri dish and take out the wick at once, very carefully, in order not to tear the hole. The disc is then put on another petri dish for drying. Protect from direct light (no darkroom is necessary) and dust. As soon as the disc is dry, put it into a dark box for keeping in a dry atmosphere. The discs will last for about 3-5 hours before the Ag NO^3 will react with the paper and cause discoloration. No disc showing even a slight discoloration should be used. It is therefore best to prepare the discs immediately prior to use. Needless to say, all filter paper should be handled with care; no fingerprints or other smudges should be retained by the filter paper; otherwise this will cause undesirable reactions.

2. *Testing Procedure*:

Have the petri dishes and the porcelain dishes ready in a box (cf. apparatus). Pour the humus extract, or whatever you want to test, into the porcelain dish. Use 5 ml of the extract to be tested (see No. 6). Put the prepared filter paper with a *new* wick over the solution on the petri dish, so that the wick just touches the bottom of the porcelain dish. Let spread until the solution reaches the first 2⅜ inch pencil mark (b_1 or b_2). This will take about 20-60 minutes. Don't let it run over the mark. Remove disc and wick and place disc again on a petri dish for drying.

3 *Developing Phase*:

The development of the pattern should take place in diffuse daylight (not direct sun).

In order to obtain comparable results the developing should be done in the same intensity of light. Unless you use measured artificial light (for instance, fluorescent lights), it needs a certain judgment as to the intensity of development; that is, when to evaluate the pattern. Just do not expose to direct sunlight.

4. *Evaluation*:

Keep discs in dark (any folder) and dry. Put a dry paper in between each sheet in order to avoid reactions between discs. Fingerprints will still show on finished discs. (Instructions for the evaluation will be given in the next issue of BIO-DYNAMICS.)

5. *Apparatus*:

The test is carried out in a box, the top of which consists of a glass plate, subdivided in three removable sections for observation purposes. The size of the box is arbitrary. We use one 36" long, 17" wide and 4" high. 12 discs can be processed in it. The box is painted with aluminum paint. It should be aired and cleaned after each use. It is wise not to crowd too many discs in one box; rather have several boxes if you want to run more tests at a time. The atmosphere in the box should be moist — close to the saturation or dew point. Therefore, we place shallow, small dishes (crystallization dishes or beakers) with distilled water at equal distances here and there in the box. This water will evaporate and maintain an even moisture. The temperature is not too essential but should be room temperature between 65°-85°F. Needed glassware,

etc.: Petri dishes, 90 mm, (3½") diam., 15 mm (⅝") high
Porcelain " 40 " (1¾") " 12 " (⅞") "
Thermometers, 2
Filter paper, Whatman No. 1, circular, 15 cm. diam.
" " " " Sheets
Test tubes, marked at 5 ml level

6. *How to Prepare Humus Extracts*:

Put 5 or 7.5 gr. of compost into a 125 ml Erlenmayer flask. Add 50 cc of a 1% sodium hydroxide solution (prepared from sodium hydroxide pellets). Mix thoroughly by twirling the flask. Let stand for extraction for 6 hours. After the first hour, twirl the flask once more and again gently after the fifth hour. After the sixth hour, pour the supernatant liquid carefully into a small beaker or large test tube. Use 5 ml for each porcelain dish.

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THE GREATEST KILLING PROGRAM OF ALL?

Reprinted, with permission, from *Audubon Magazine*, November-December, 1958.

One of the most devasting mass-killing programs in the history of insect control, conducted for the past ten months by the U.S. Department of Agriculture and certain state pest control agencies is currently scheduled to continue for several years. On 27 million acres in nine southeastern states—Alabama, Georgia, Louisiana, Mississippi, Florida, Texas, Arkansas, North Carolina, and South Carolina—either granular heptachlor or dieldrin has been, or will be, broadcast from aircraft at the rate of two pounds to each acre. The control program is aimed at control of the imported fire ant. However, both of these deadly chlorinated hydrocarbons have killed great numbers of insects, birds, mammals, fishes, reptiles, amphibians, and crustaceans in the 400,000 acres that have so far been treated.

Your Society*, after a six month survey based upon field inspections during the period of aerial application of the poisonous chemicals, interviews with persons engaged in the control operations and research, and a review of the scientific literature, has concluded as follows:

Almost all wildlife species in the areas treated were affected. These areas may remain acutely toxic; even two months after the poisons were applied, newly killed animals were picked up in the treated areas. The pest control agencies themselves claim that the insecticides will remain lethal for at least two years.

Insects were the first animals to die. Within 30 hours after treatment, alarming numbers of dead insects, many of them essential to controlling the population of other insects, and useful as a food supply for birds and mammals, were reported in Georgia and Texas.

In Alabama, Georgia, Louisiana, and Texas, songbirds and gamebirds were found dead in the treated areas within two days

**The National Audubon Society.*

after poison had been spread to kill fire ants. The U.S. Fish and Wildlife Service announced that quail in poisoned areas of Alabama and Texas were decimated or wiped out. Analyses of the tissues of 38 birds killed in Texas disclosed heptachlor and heptachlor epoxide in each. The terrible effect on birdlife subjected to the insecticides during the nesting season was dramatically shown in Texas. In a 60 acre clover field, 38 of 41 nests with eggs were abandoned or destroyed, and a biologist's report summarized the devastation as follows:

> "Bird populations along ranch roads in the treated (poisoned) areas were reduced 92-97 per cent in two weeks. Bird populations within acre plots studied were reduced 85 per cent in two weeks . . . Large scale abandonment of nests with eggs could be explained only by the mortality of the adults. The missing birds did not appear in adjacent areas."

Mammals also were destroyed—rabbits, squirrels, raccoons, opossums, nutrias (a fur-bearing animal), armadillos, cotton rats, and white-footed mice. Rabbit populations were hard hit or wiped out in Texas, and even fox cubs were found dead in a den in Louisiana in an area where many other mammals also were killed. Heptachlor was detected by chemical analysis in the tissues of many of the dead animals.

Animals that live in the water are even more susceptible to the chlorinated hydrocarbons, of which heptachlor and dieldrin are especially lethal. In Texas, snails, fishes, and crustaceans, on which many birds and mammals feed, were devastated the second or third day after water areas had been poisoned. In Alabama and Louisiana many kinds of aquatic animals were killed including fishes and frogs *up to seven weeks after the poison had been applied.*

Earthworms were reduced by almost 80 per cent in poisoned plots in Louisiana, and as yet, no one knows how long or to what extent the residues of the poisonous insecticides may affect other soil organisms.

Even domestic livestock had severe losses in the poisoned areas. Near Climax, Georgia, a veterinarian reported that more than 100 head of cattle died suddenly after the area they were in had been massively sprayed with dieldrin. Mules, goats, turkeys, chickens, and other farm animals were also reported to have died. The animals died suddenly, with the fits and convulsions characteristic of insecticidal poisoning. In the same area, the veterinarian reported that more than 100 brood sows had a com-

plete reproductive failure following the spraying. In other parts of Georgia, cats were found dead in the poisoned areas.

What is the justification for a mass insecticidal spraying program that can make the areas treated almost lifeless? The imported fire ant, a South American species discovered near Mobile, Alabama some 30 years ago (against which the poisoning campaign in the Southeast is aimed) is not a serious threat to southern agriculture, despite the absurd claims that it destroys major crops, seriously affects livestock and wildlife, and threatens human life.

In 1949, investigators for the Alabama State Conservation Department could find "no evidence that the fire ant preys upon either cultivated or wild plants." A recent report of a study at Alabama Polytechnic Institute substantiated the 1949 report and noted that the ants were found in cotton fields taking boil weevil larvae from cotton squares, which suggests that the imported fire ant may be highly useful in suppressing certain insects that threaten commercial crops. Even the USDA's own Cooperative Economic Insect Report, which summarized insect populations and damage for 1957 did not mention any serious losses from fire ants in any southeastern state!

The National Audubon Society has urged that the pest control agencies which are involved should stop the massive spraying of toxic chemicals used in efforts to control insects. It has urged that fire ants should be controlled, when and if troublesome, by local methods which will not seriously endanger other kinds of wildlife. Your Society has also recommended a greatly expanded program of research to determine the cumulative, as well as immediate, effects of pesticides on all forms of life, and that greater emphasis be placed on more selective methods of insect control.

AGRICULTURAL CONFERENCE GOLDEN ACRES FARM, October 1958

DAVID GLASSER

Heintz Grotzke delivered a practical lecture on the planting, cultivation, and care of fruit trees. In the course of this talk, he presented data which would indicate that a shift takes place between the proportion of destructive, useful and apparently neutral species in the insect population of an orchard after insecticidal and fungicidal sprayings. (Obviously, this refers to the effects of strong chemical pesticides. Editor) In both instances,

there was an increase in destructive insects with a corresponding decline of useful and neutral species.

Mr. Grotzke reported his belief that the method of insect control employed by fruit growers is dictated by the changing demands of the consumer. When an unblemished product was desired, chemical control was practiced. When the consumer grew alarmed about poisonous residues, biological control was initiated. Now, the consumer has evolved to a point where he not only demands a product free from external contamination but also a fruit with intrinsic nutritional quality, a demand which can be satisfied only by biodynamic methods of control.

Biodynamic seed production was the second of Mr. Grotzke's topics. He said that once such production of seed is achieved the cycle of biodynamic gardening will be complete.

Commercial seed producers focus on quantity. They are engaged in breeding seeds that will yield more per acre, increase in bulk is their aim. Biodynamic efforts will be directed toward correcting the results of such a one-sided emphasis: the deterioration of nutritional quality, the decline in capacity to resist disease and frost, and the loss of viability. Although germination figures reported on the labels of commercial seed packets appear high, they are misleading. For they are calculated by placing the seeds on moist filter paper, and counted as positive as soon as the sprout ruptures its casing. Biodynamic seeds are germinated in soil, allowed to develop a root system and three leaves before qualifying.

Seeds are usually stored indoors during the winter. Mr. Grotzke plans to reintroduce the seed into the natural rhythm of the seasons, rather than exposing them for several months to the artificial environment of the storeroom. Seeds will spend the winter out-of-doors. Another method of achieving this readaptation is the immersion of the seeds in ice water for varying periods of time. By these means, a domestic crop seed may be produced that will be able to resist the frost as well as their more robust, wild ancestors, the weeds.

Herbal baths will be prepared for treating the seeds. They will serve to disinfect and stimulate the seed. Certain herbs contain alkaloids, which are known to possess stimulating properties. Other herbs contain substances, which are not only insecticidal and fungicidal but are known to influence plant growth.

Most seeds which one buys nowadays are coated with a fungicide, such as dieldrin, or are packed in a fungicidal dust.

Seed, germinating in such an environment, might be influenced to produce enzymes and protein deviating from the normal. The end result of defective protein is believed by Mr. Grotzke to be the rise of virus diseases in plants. To combat this trend toward degeneration, biodynamic seeds will be coated with a living material, organic in nature, composed of cow manure, an animal product, fortified with various natural additives.

Mr. Grotzke listed the steps to be followed in seed production: growing the plant, pollination, selection of the seed, harvesting, drying or fermenting the seeds, shelling in some cases, and cleaning.

Only seed from ripened fruits will be harvested. Commercially, harvesting is mechanical and unselective. A machine is sent once through a field, collecting seeds at various stages of maturity.

At the close of Mr. Grotzke's talk, Dr. Pfeiffer presented additional material on the subject of seed production. Reports on his work in this field have appeared in the Spring and Summer issues of BIO-DYNAMICS, Nos. 46 and 47, 1958.

Dr. Pfeiffer spoke chiefly about problems of nutrition: the nutrition of the soil life with compost, the nutrition of poultry, cattle, and human beings. In each instance, he emphasized that the balance between quantity and quality should be maintained. One-sided quantity production does not lead to quality. It is often possible to reduce the amount consumed or applied of a high quality product. For instance, with a *quality* compost the rate of application can be reduced from ten tons per acre to three tons per acre and less in special cases. Another example would be in poultry feeding. Thus a formula with 14% protein of a high quality can bring good results where formerly 20% and more was necessary. These reduced amounts achieve the desired effect of the higher figures only because they represent a more balanced food.

In animal feeding, the factor of taste must be taken into account as well as that of smell. A cow has a greater differential sense of taste than a human being, for one reason, because its tongue is equipped with 35,000 taste buds, seven times as many receptors as possessed by a human being. The dog, because the upper section of his stomach is lined with tissue similar to that in his mouth, can perceive taste after he has swallowed, which explains why appealing and appetizing food disappears almost immediately when it enters the animal's mouth. The dog also has a

more sensitive sense of smell. Dr. Pfeiffer reported that the two nostrils can register different odors. A dog will first sniff with one, then with the other. For better digestion, these sense receptors should be stimulated. Bovine rations should be supplemented with herbs during the winter months when the cow can no longer forage for these stimulants in the field. The feeding of concentrates impairs an animal's sensitivity. A cow feeding in the field using its normal instincts will rarely commit the error of eating a toxic plant, but when confined to a stall, she loses this ability and may swallow a poisonous substance. This can prove fatal to horses; because they cannot regurgitate, they are obliged to digest whatever arrives in their stomachs and admit it into their system.

Dr. Pfeiffer pinch-hit at the rostrum for Dr. Coda Martin, who was unable to speak at the conference, reviewing the progress made in nutrition during the past year. He underscored the importance of each meal containing a complete and balanced mixture of amino acids for the proper maintenance of life and growth. The quality of a protein and its biological value is a function of its amino acid spectrum. Eight amino acids are essential in the diet, for the body is unable to synthesize them from any other material at hand. If they are not supplied simultaneously to the sites of protein production in the body, they are ineffective. Feeding the missing amino acids at the next meal is of no avail; if not immediately utilized, they are converted to fuel for energy, for amino acids can not be stored.

Dr. Pfeiffer cited the work of E. S. Nasset*, who investigated the absorption of amino acids. If the mixture of amino acids in the small intestine is incomplete, endogenous (from within the body) protein supplied by the cells of the mucous membrane lining the organ and from digestive enzymes are broken down and their amino acids donated to the mixture to complete it before it will be absorbed. By this homeostatic device, the body assures the liver and other sites of protein synthesis a mixture of amino acids constant in composition. This illustrates a balancing mechanism, employed by Nature to correct the errors in our diet, compensating for the imbalances, of excess and deficiency, created by our unnatural eating habits. A similar example of this mechanism can be found in the plant realm. Leaves can selectively assimilate elements from the air and transport them directly to the root where they are excreted into

*"Role of the Digestive Tract in the Utilization of Protein and Amino Acids", E. S. Nasset, Ph.D., Journal of the American Medical Assoc., May 11, 1957. Vol. 164

a soil lacking them. They serve merely as conductors of nutrients, required to correct an imbalanced condition of the soil in which the plant is growing.

Perhaps the most serious nutritional disorder in this country is excessive eating. This condition produces physiological stress by taxation of the liver and the kidneys. The liver is the first organ to receive the absorbed nutrients via the portal vein. There, glycogen (a carbohydrate) and fats are synthesized and stored; amino acids are coupled together in different amounts and arrangements to produce different proteins. This amounts to much activity, requiring the expenditure of energy for the work of processing the food. Normally, the liver works at a feverish pace, 101 degrees F, some 2.4 degrees higher than body temperature.

Dr. Pfeiffer would reduce the daily requirement of protein to a figure which is considerably less than the 130g. consumed in practice. Such reduction would of course be dependent on having a protein of high quality and the proper amino acid balance. This would relieve the liver. The intake of carbohydrates and fats should be cut down in proportion. Besides the physiological stress it causes, the overconsumption of carbohydrates and fats produces deposits in excess of the amount required for metabolism and growth, resulting in a waste of these "idle calories".

Russell Keep, reporting on the marketing plan which he had originally outlined at the Spring Valley Conference in August, described how in three months through the development of organic co-operatives Golden Acres had been able to change a situation of surplus at medium levels of production to shortages at high levels of production. In New York, Long Island, New Jersey and eastern Pennsylvania consumers interested in organic foods are joining together to form co-operatives. (At the home of one of the members of a co-op deliveries are made each week by Golden Acres from orders given by each of the members a few days in advance of the shipment day.)

To meet the demand from these growing consumer co-operatives, other farms are joining with Golden Acres to form the nucleus of a farm co-operative which will insure a steady and varied supply of organic foods produced under approved conditions. The advantage of this form of co-operative marketing is that it is small and direct. The farms which produce the food are responsible for the quality of the food because they are responsive to individuals rather than to the mass market.

A NEW GREGG PUBLICATION

We are pleased to be able to reprint here a few pages from a new book by that old friend of Biodynamics, Richard B. Gregg. The work is primarily directed towards the problems of India, from which country the author and his wife, the former Evelyn Speiden, have in recent months returned. Nobody is under the illusion that the American farmer or professional grower can survive without paying attention to "money methods of measuring and valuing" his agricultural activities. Yet the underlying realities to which Mr. Gregg points are among those so easily forgotten in the day-to-day struggle that one cannot help feeling it is good to have them laid before us. Often, along with the economically forced mechanization of so much of American farming and truck growing, the man who has a genuine regard for his soil and what it produces will be faced with the question of whether or not to include, in their proper place, biologically stimulating activities, take for instance the application of the B. D. Tree Paste. We may be tempted to neglect the sound principle that what is biologically sound is also, in the long run, economically the most profitable.

Extracts from:
GREGG, RICHARD B. *A Philosophy of Indian Economic Development.* Ahmedabad: Navajivan Publishing House, Ahmedabad, 1958.

One reason for the increase of industry at the expense of agriculture in the West is because of money methods of measuring and valuing all activities. If money measurements are the sole standard, then in order to make big profits you must cut down costs as much as possible. Wages are in many industries and in agriculture a large item of cost. So the tendency is to introduce, if possible, a machine to do the work of many men, more quickly than they can. Or in accounting terms, you try to cut down on the man-hours of work. Man-hours are units of work, used primarily as the basis of calculating wages. So efficiency tends to be measured by the unit of man-hours, in agriculture as well as industry. Machines reduce both the number of men and the number of hours on a particular piece of work. The men thus displaced from agriculture, by the introduction of machinery into agriculture, have to go to the cities to find industrial work or so-called "service" jobs.

But there is a mistake in this thinking. Since farming is a transformation of solar energy, and that energy is measured as

so much per unit of area on the earth, agricultural efficiency of production ought to be measured not by so much *per worker*, but as so much *per acre*. It is general experience, outside of temperate arid regions anyhow, that intelligent intensive farming produces more per acre than large-scale machine farming. Intensive farming is best done by small units. If machines are powered only by people or animals, there is a healthy, ecological limit to production. This means small farm and village life. But such farming requires much handwork and therefore many workers. Thus it tends to keep a sounder balance between the number of workers employed in agriculture and the number employed in industry. Hence, intensive small-scale farming (village life) proves to be in agreement with fundamental engineering concepts applied to agriculture. A man-hour appears not to be a sound unit for measuring agricultural efficiency. Paying too much attention to money profits and money measurements interferes with both the amount of goods produced and the sound balance of national activities. Also it promotes the exploitation and waste of natural resources[1]. On the other hand, the realization that solar energy is the ultimate source of all physical power, when followed out to its implications in both industry and agriculture leads to sound balance between the two.

Let me give a specific example of how intensive farming using much human labour per acre not only produces more crops per acre but also, surprisingly, is practically as efficient in terms of food energy output in relation to total energy expended as is highly mechanized farming. The figures relate to pre-war United States and pre-war Japan. The quotation is from pages 162 and 163 of *The Next Hundred Years* by Harrison Brown (geochemist), James Bonner (biochemist) and John Weir (psychologist)[2]:

"We know that productivity per farmer is high in the United States, where the farmer has available a plentiful supply of energy to supplement his own, and that productivity per farmer is low in cultures in which the farmer must provide most of the energy himself. The following analysis shows, however, that the energy output in the form of farm products depends on the total energy put into the operation rather than on the form in which the energy is applied.

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1. See my **Which Way Lies Hope?**, Navajivan Press, Ahmedabad, 1957.
2. Viking Press, New York, 1957. They took the figures from **World Population and Production** by W. S. and E. S. Woytinsky, **The Twentieth Century Fund**, New York, 1953.

Country	Total Energy Input Per Day (Calories) Per Farm Worker		Per Acre		Energy Output of Farm Produce Per Day (Calories) Per Acre
	Human	Supplementary	Human	Supplementary	
United States	350	4,950	10	140	4,000
Japan	350	100	420	120	13,000

"As the preceding table shows, the United States farmer expends almost 5,000 calories per day in addition to his own energy. The Japanese farmer expends only 100 calories per day in addition to his own. But farms in the United States are bigger than in Japan, so that more total energy is expended on an acre of Japanese farm land than on an acre of United States farm land.

"The following table summarizes the energy efficiencies of farming in the two regions. This efficiency is nearly the same, since in the United States we obtain about 27 calories of potential food per calorie of energy expended in farm work, while in Japan 24 calories of potential food are harvested for each calorie expended.

"Let us look at the efficiency of food production per unit of human energy expended. From this point of view the United States farmer is thirteen times as effective as the Japanese. Note, however, that the Japanese farmer uses his supplementary (non-human) energy more efficiently than does the United States farmer. The latter may run around more.

Country	Output of Food Calories Per Calorie of Energy Input		
	Human Energy	Supplementary Energy	Total Energy of Food Produced Per Calorie of Input
United States	400	29	27
Japan	31	108	24

"Japan, which has the world's most intensive agriculture, produces over 13,000 calories of potential food per acre per day—over 3.5 times as much as the world average of 3,800 calories per acre per day[3]."

3. This last quoted paragraph is from page 58 of the same book, **The Next Hundred Years.**

These figures are encouraging for India. India, like Japan, has mostly very small farms and large numbers of agricultural labour who need employment. Skilled intensive manual work on the farms can produce larger crops per acre than can be had by farm mechanization and only about ten per cent less efficiently in terms of total energy expended. That ten per cent difference is more than compensated for by the economic and moral advantages of maintaining full rural employment.

City people, who are in control of the political and economic policy of most countries, take for granted that there will always be enough food. For them almost any kind of activity seems more interesting and important than mere farming. Except when travelling, they do not see the fields. They can accept intellectually the fact that man has to eat and that, except for fish, all food comes from the land; but to feel vividly the importance of farming and of all its processes and the peasants who perform them is beyond their imagination. City people do not realize, as George W. Gray wrote, that "neither the human body nor that of any animal is able to synthesize sugar or any other organic compounds from inorganic materials. The animal kingdom is thus parasitic on the vegetable." The protein molecules are built up in the beginning only in the vegetable kingdom.

Man is utterly dependent on plants and on the condition of the top ten inches of soil that feeds the plants. As is so vividly told in that interesting book, *Top Soil and Civilization*[4] practically all the twenty or more civilizations in human history (such as Babylonia, Sumeria, Greece, Roman Empire, Persia, and so on) have ignored that dependence and, in their search for wealth and power, have destroyed the soils which supported them and then themselves perished. Western man is now repeating the pattern.[5] Will India continue to follow the same path?

Bertrand de Jouvenal, an eminent French economist and political philosopher wrote recently in the Bulletin of Atomic Scientists:[6]

"Western man has a narrowly anthropocentric view of the universe. Nothing seems to him precious and worth preserving, other than man. He tends to count nothing as an expenditure, other than human effort; he does not seem to mind how much mineral matter he wastes and, far worse, how much living matter

4. By Tom Dale and Carter Vernon, University of Oklahoma Press, U.S.A., 1955.
5. See my **Which Way Lies Hope?**
6. In an article entitled "From Political Economy to Political Ecology", October, 1957, pp. 287-291. It was a summary of a talk he gave in Tokyo at a conference on Problems of Economic Growth.

he destroys. He does not seem to realize at all that human life is a dependent part of an ecosystem of many different forms of life. As the world is ruled from towns where men are cut off from any form of life other than human, the feeling of belonging to the ecosystem is not revived. This results in a harsh and improvident treatment of things upon which we ultimately depend, such as water and trees.

"Mankind has only quite recently, and in its lesser fraction, entered into the Industrial Age. Our power to tax Nature is increasing and is ever more widely used; it is also a power to destroy. This is a problem which begins to appear under certain aspects (pollution, erosion, local scarcity of water) even in resource-rich America; it must appear at an earlier stage in countries less fortunately endowed. My stand is not an anti-progressive one. I am aware that our techniques are not only capable of impairing but also of repairing natural resources, provided we put our minds to it. This will increasingly claim our attention, and it must claim attention in resource-poor countries, from the very inception of their development. More generally, we shall be led to regard Nature not as a store on which we can freely draw, but as a flow which we must be careful to replenish. It will greatly help us toward such an attitude to realize that human life is completely dependent upon a great company of other forms of existence. This is why I speak of Political Ecology."

PROGRESS NOTES FROM JUNIPER FARM

Many of our readers know of Juniper Farm and the Walter Buschmans through having eaten one or another of their whole wheat products, bread made from bio-dynamic flour, or hot breakfast cereal. Not too many of you have had an opportunity to visit their place at Sugar Loaf, Orange County, N. Y. The following material from a folder sent out by them recently may serve to give you all, old acquaintances and new, at least a fragmentary picture of what has been growing up there through the years.

The Buschman family came to Juniper Farm in 1944 and worked it as a general farm with dairy cows, chickens, pigs, etc. We have raised our own calves and gradually built up the herd from a small nucleus. The dairy exists now both for milk and for the manure which has improved the soil over these years.

Our first flour mill was to supply bread for ourselves and a few neighbors. Now we have three mills for stone ground flours and cereals, plus an imported cleaner which does very effective work in getting rid of impurities and selecting the grains. We package and mail now all over the states, and to Canada and Mexico.

Our products are outstanding because they are grown by the Bio-Dynamic Method. What does this mean? First, — generally recognized good farming practices with crop rotation, soil aeration and the use of organic fertilizers. The manure is not applied raw, directly from the dairy barn but is turned into humus by the use of Dr. Pfeiffer's *B. D. Starter*. Then too, we use the Bio-Dynamic Sprays, — one called 500 on the soil, another, 501, on the foliage. These are not poisonous sprays for killing, but beneficial and invigorating to both the micro-organisms in the soil and the assimilation processes in the leaf. All this makes for superior nutrition both for animals and man.

The nutritive factors in the grains have been tested annually at the Biochemical Research Laboratory of Dr. Pfeiffer. The most recent tests indicate that the protein content of this year's wheat is very stable so that the wheat should store well.

With some 250 acres of land, we now have under cultivation more than in earlier years and can grow most of our own wheat instead of depending on other Bio-Dynamic farms for our supply. In addition there is pasture and hayland for the cattle. We have gradually increased our herd by keeping all the young stock and now have beef cattle which are available for meat. Now some of our own home grown beef is on hand, — steaks, roasts, hamburger, etc.

Over the years knowledge of our products has spread by word of mouth from one friend to another. As the circle of customers has grown and widened we have tried to build up our production on a solid basis to meet the gradually increasing demand. Our desire is to continue to grow in the same organic fashion.

ANOTHER ASPECT OF "CONSERVATION"

Ordinarily, reports of the activities of such craftsmen as bookbinders would hardly find their way into these pages. However, since a couple of new settlers in the Threefold Farm community, Spring Valley, N. Y., have made a special offer to our

readers to bind the first 38 numbers of Bio-Dynamics (i.e. up to Fall, 1955) in three volumes for $10.00, we felt an exception was called for.

Mr. and Mrs. Arnold Leaver, both originally from England, are bona fide *settlers* too, currently rehabilitating from the ground up an old tumble-down house on a couple of acres that have recently become part of Threefold Farm and living in the meantime in temporary quarters here with someone else. They spent the first few weeks on this project just grubbing out the jungle (and accumulated trash) around the house so that they can start some kind of a garden in the Spring.

But what is of immediate concern here is that they do excellent bookbinding, many readers use back numbers of the quarterly as reference books, and the Leavers' offer makes it possible for one to conserve these paper-backed issues indefinitely. The price is contingent on the numbers still being in good condition. "Beat-up" copies require a lot more work, and this would increase the costs. They, of course, will also bind more recent numbers, or any other books that need re-doing. They can be reached by mail at Threefold Farm.

F. H.

RESIDUES IN MILK

Reports of concern by individual scientists and unofficial agencies over the potential health hazards of insecticide residues and even small amounts of penicillin in milk are no rarity. It is of special interest, however, to read in THE NEW YORK TIMES of February 20th, 1959, a report by Murray Illson quoting George P. Larrick, United States Commissioner of Food and Drugs, and W. B. Rankin, Assistant Commissioner, on this subject. The dangers from such materials, "found in some milk supplies", were referred to in a paper by Commissioner Larrick, read by the Assistant Commissioner at a recent New York City conference of dairy industry officials.

Mr. Rankin was quoted as having said later in an interview that *the Federal Government might have to ban penicillin in the treatment of mastitis in dairy cows unless farmers used the drug properly.* (Italics ours.) He stated that in 3½% of 1,100 samples recently tested, penicillin was found. Among the areas furnishing samples in which none was found, he reported, was the Buffalo area, described as furnishing the bulk of the milk

supplies of New York State. The same was true of the Minneapolis and New Orleans areas. Most of the residues were, he said, in samples taken from the Boston, Chicago and Kansas City areas.

He was further quoted as having said that a panel of medical experts had reported to the Food and Drug Administration, that penicillin in milk could be "a real hazard" to a relatively small percentage of people who were "exquisitely sensitive" to this drug.

Residues of chlorinated hydrocarbons, particularly DDT, he also stated, were found in about 4% of 800 samples of market milk. The interviewer quoted him as adding that although these residues were "very minute", their presence in milk could not be tolerated and State and Federal agencies must keep them out.

Addressing the meeting, Mr. Rankin referred also to "some disturbing reports recently that the wax materials used to coat cardboard milk containers extensively employed for milk products may not be entirely suitable for the purpose". Adding that the American Petroleum Institute was sponsoring an extensive study of the composition and safety of these waxes, he went on to say that "we in the Food and Drug Administration need to undertake some laboratory studies of our own. We have done some preliminary work, but have not been able, with the funds available to us, to do the job that should be undertaken."

F. H.

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